Nutritional composition and caffeine content of coffee-galangal affected by the variation of sweetener addition

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ABSTRACT

Coffee-galangal is a herb coffee, a mixture of coffee powder and galangal powder, which has a different aroma and taste and the galangal itself has excellent properties for the body. The sweetener commonly used in products is sucrose based sugar. The purpose of this study was to determine the effect of the use of sweetener on the chemical properties and caffeine content, such as cane sugar, palm sugar and alcoholic sugar. The nutritional composition were determined by carbohydrate content, protein content, fat content, water content, and caffeine content. The addition of sweeteners in the form of cane sugar, palm sugar, and alcoholic sugar is in coffee-galangal was significantly different from the unsweetened control treatments on the parameters of carbohydrate content, water content, ash content, and fat content, but did not significantly affect protein content. The use of different types of sweeteners added to coffee-galangal products significantly (α = 5%) on total carbohydrate, water, ash, and fat content. The parameter values of the chemical properties of the product in this study were: carbohydrate content of 64.47-82.60%, water content 5.19-17.08%, ash content 1.74-4.47%, fat content 3.25 - 6.79%, protein content from 4.96 to 7.5%, and caffeine content 0.68 – 1.79 %. Finding in this study showed that alcoholic sugar has the highest percentage of caffeine content and the lowest carbohydrate content.

Key words: Herb coffee; Coffee-galangal; Sweetener; Chemical composition; Caffein.

1 INTRODUCTION

The production of processed herbal beverages, which are included in agro-industries made from local commodities, is based on the number of herbal plants especially in Indonesia. One of the herbal plants, which are often used as an essential product, is galangal. This commodity is a medicinal plant and is grouped into members of the Zingiberaceae family with the order Zingeberales. The galangal plant has the scientific name *Alpinia galanga (L.)* Willd. Rhizome and galangal fruit is the most nutritious part of the galangal plant. Efficacy of galangal, namely as a remedy for rheumatism, stomach ache, treating cold, pneumonia, bronchitis, inflammation of the stomach, coughing, increase decreased appetite, and reducing swelling (Basri; Taha; Ahmad, 2017; Xie et al., 2013). Moreover, galangal also known to possess antimicrobial, antioxidant, antifungal, antiviral and anti-cancer (Das et al., 2020; Półtorak et al., 2018; Tang et al., 2018). *A.galanga* is highly appreciated for potential application in food and medicine.

The composition of coffee consists of many volatile and non-volatile components, such as phenolic chlorogenic acid, di terpenes and caffeine, are alkaloid that can be found in large amounts more in coffee than in any other dietary products (Messina et al., 2015; Weldegebreal; Redi-Abshiro; Chandravanshi, 2017). Nowadays, health promotion of food is now carried out as awereness of healthy food comsumption. Coffee, as beverage is one of important daily diet and hold second position in consumption after water. Caffeine as the major composition of coffee and the active ingredient (Butt; Sultan, 2011; Esquivel; Jiménez, 2012). Moreover, information on the chemical composition of coffee, habitual coffee consumption and the potential impact of specific components on our health and well-being is affect consumer choices (Gloess et al., 2013; O'Keefe et al., 2013; Ribeiro et al., 2018). The pleasant taste and aroma of coffee and the stimulating properties that arise from its caffeine content are always the reasons why many people love coffee (Jeszka-Skowron et al., 2016; Masi et al., 2013; Sanlier; Atik; Atik, 2019). The antioxidant content of coffee is mainly attributed by chlorogenic acids, ferulic acids, caffeic acids and melanoids (Tewabe Gebeyehu, 2015).

The coffee-based food products are one of the diversification and innovation of processed coffee products on the market, such as herb coffee, ice cream, bread, early-roasted Java coffee powder, gluten-free cookies and functional coffee beverage (Damat et al., 2019; Kumar et al., 2019; Lestari; Susanti; Legowo, 2018; Peñuela-Martínez; Zapata-Zapata; Durango-Restrepo, 2018; Sunarharum; Yuwono; Aziza, 2019; Vasudevaiah et al., 2017; Yüksel; Şat; Yüksel, 2015). In other hand, the addition of some spices that have a health effect could increase the value of coffee itself. Herbal coffee is currently in great demand by producers and consumers in Indonesia, herbal coffee is a variant of processed coffee products and herbal plants that provide distinctive aromas and flavors. There have been

many studies that discuss this topic, bioactive composition of brew coffee affected by milk addition (Niseteo et al., 2012), effect sugar addition on phenolics of coffee (Ludwig et al., 2013), coffee with cinnamon (Durak; Gawlik-Dziki; Pecio, 2014), Ginger Teripang coffee (Dinanty; Dewi; Mujiharjo, 2017), Coffee-Clove-Ginger formulated powder (Lestari et al., 2018), and fruit coffee (Secilmis; Yanık; Gogus, 2015). The previous studies, besides explained how to combine the coffee with spices, its explained the physiological effect that might be contained in it.

One of the ingredients in making coffee-galangal is sugar. This sugar is the type of sugar that is most easily found, used daily to sweeten food and drinks. The selection of types of natural sweeteners that can cause health effects need to be considered in the processing of health food products (Lee; Kim; Kim, 2017). Sugar addition in coffee is partly a function of fundamental individual differences in physiology, including the sensory characteristics of food and beverage (De Alcantara; Freitas-Sá, 2018; Masi et al., 2015). This information is essential in product development and marketing. In addition to sucrose in cane sugar, there is palm sugar and alcoholic sugar. which are sweeteners but have a lower glycemic index than cane sugar. Palm sugar has a glycemic index value of 35, lower than granulated sugar with a glycemic index value of 58 and alcoholic sugar sugar has a sweetness level of 50-70% below sucrose and a low calorific value of 2.6 cal.g^{-1}.

In this research, sugar sweetener, palm sugar and alcoholic sugar sugar will be used. The specific purpose of this study was to determine the effect of using the best type of sweetener on the chemical properties of coffee-galangal products. The urgency of this research is to obtain information in the form of formulation and nutritional value on the innovation of coffee-galangal products that are important for the coffee-galangal agro-industry, specifically the business of coffee-galangal products.

2 MATERIAL AND METHODS

2.1 Materials

Coffee beans used in this research were Java Robusta coffee cultivated on Arjuno Mountain, UB Forest Malang, East Java, harvested in 2017. Samples of cane sugar, palm sugar, and alcoholic sugar were purchased from retail market.

2.2 Methods

The method used is a completely randomized design method with 3 replications, the addition of sweetener treatment with 4 levels, control, cane sugar, palm sugar, and alcoholic sugar. Coffee-galangal processing procedures started with preparation of galangal powder and ginger powder by size reduction dan termal processing.

Galangal and ginger is washed from the remains of the soil, then cut into small pieces. Put in a blender and add enough water to get grated ginger. Strain the ginger water from the grated. Let the juice sit for a few minutes so that there is a sediment at the bottom of the container. Separate the ginger juice from the white sediment at the bottom of the container. Put the ginger juice in a frying pan and add sugar then heat it over medium heat. The juice continues to be stirred periodically. After the ginger water boils then reduce the heat and continue to stir until thickened. When it thickens, the instant ginger is almost ready. Keep stirring until you get instant ginger powder.

The ginger powder is blended again to get a small powder size.

Roasted Robusta coffee powder mixed with powder mixture of galangal powder (10% w.w^{-1}) and ginger powder (2% w.w^{-1}, then after mixing it perfectly, sweetener is added with coffee-galangal ratio: sweetener is 1: 1, then the size is reduced by 80 mesh with the aim of getting smaller and uniform product particle size so that it is easy to brew as a beverage. The nutritional composition were determined by carbohydrate content, protein content, fat content, water content, and caffeine content. Proximate analysis was performed following AOAC standards for the raw coffee beans (non-roasted) to get information on initial properties. For the analysis of chemical characteristics, the frozen coffee beans were directly ground into powder. Moisture content was analyzed based on gravimetric method II using vacuum oven. Crude fat was analyzed using Soxhlet extraction method, protein was analysed using Kjeldahl digestion method, ash content was determined based on dry method, while carbohydrate was calculated by difference. The content of caffeine was used HPLC (Danhelova et al., 2012). The experiment was set up in a completely randomised design. Analysis of variance was performed on the data, and significant differences among treatment means were calculated by Duncan's multiple range test ($P < 0.05$).

3 RESULTS

The results of the carbohydrate test with the highest value were in the addition of sugar cane and the lowest was in the addition of alcoholic sugar (Table 1). The levels of caffeine in coffee-galangal with the addition of sweeteners studied were shown in Table 2.

4 DISCUSSION

4.1 Carbohydrate Content

Table 1 shows the product quality parameters seen from their chemical properties. Total carbohydrates from coffee-galangal with sweetener variants range in value from 64.47%

to 82.60%. The results of the carbohydrate test with the highest value were in the addition of sugar cane sweetener treatment at 82.60 ± 3.48c% and the lowest was in the addition of alcoholic sugar sugar treatment at 70.40 ± 2.57b%. Compared to unsweetened controls, the increase in total carbohydrate levels in the treatment of alcoholic sugar sugar addition was 5.97%, smaller than the increase observed in products with the addition of cane sugar and palm sugar. Cane sugar or commonly called granulated sugar is sugar derived from sugarcane juice with high calorie crystallization with a total carbohydrate value of 94%. Similarly, the content of glucose, fructose and sucrose in palm sugar is also high, ranging from 62-72%.

Judging from the DMRT follow-up test with a significant effect (α = 5%) on differences in treatment of total carbohydrate levels, it shows that the addition of cane sugar and palm sugar does not have a significant difference. Fructose was found the largest portion in all coffee beans grown under different shading conditions and the main component of coffee is carbohydrates (up to 50%) (Somporn et al., 2012; Vasudevaiah et al., 2017). Alcoholic sugar showed the significant carbohydrate content than other type of sugar added. The use of food products with low calorie sweeteners, namely polyol sugar compounds, has begun to be widely applied in industry. Alcoholic sugar sugar is a sugar that is widely used. The advantage of the polyol sugar compound is that it cannot be metabolized by insulin so it does not affect blood sugar levels.

4.2 Water content

Table 1 shows the water content of coffee-galangal with sweetener variants ranging in value from 5.19 to 17.08%. The results of the test of water content with the lowest value are in the treatment of adding cane sugar sweetener that is equal to 5.19 ± 0.17a % and the highest is in the treatment without adding the sweetener by 17.08

± 0.27d%, compared to the treatment of adding sweetener, control unsweetened has a very low water content. The final water content of coffee subjected <12% in order to inhibit microbial spoilage and prevent chemical deterioration, the water contained in coffee powder is the result of the coffee bean processing process, namely roasting and curing. In this study an analysis of water content was carried out in order to analyze how much water was bound in coffee-galangal with the addition of different sweeteners. This result can be taken into consideration in the packaging and storage process in order to have a good product quality.

The water content of coffee-clove-ginger formulated powder were 5.26-7.49%, but it might be increase during storage. The temperature and relative humidity of the surrounding the product should be maintain to minimize the alteration that affect important parameters of the product. Judging from the follow-up DMRT test with a significant effect (α = 5%) on differences in treatment of water content, it shows that the addition of sweetener variants both cane sugar, palm sugar and alcoholic sugar sugar have significant differences on coffee-galangal without sweeteners. The coffee with alcoholic sugar added had higher water content than sugar and palm sugar added coffee, because alcoholic sugar is hygroscopic and able to bind free water, the higher addition of alcoholic sugar, the more water free bound. Sugar products have different water contents depending on the type of processing given. The treatment of adding different sugars to ground coffee will change the percentage of water content in the product due to differences in the water content contained in the three types of sweeteners. This will affect the binding of free water in the coffee-galangal product itself. The presence of many polar free hydroxyl groups in sweeteners also affects the process of water absorption, hydroxyl groups facing the surface of the material will be able to absorb water and bind to other polar group.

Table 1: Proximate data of galangal-mixed coffee.

Type of sugar	No sugar	Cane sugar	Palm sugar	Alcoholic sugar
Water content	17.08 ± 0.27c	5.19 ± 0.17a	10.05 ± 0.06b	14.50 ± 0.60b
Ash	4.17 ± 0.24c	1.74 ± 0.19a	2.71 ± 0.03b	3.27 ± 0.05b
Protein	7.50 ± 3.15	7.21 ± 2.97	4.96 ± 0.17	6.44 ± 2.05
Fat	6.79 ± 0.04c	3.25 ± 0.64a	3.30 ± 0.05a	5.39 ± 0.49b
Carbohydrate	64.47 ± 3.16a	82.60 ± 3.48c	78.98 ± 0.21c	70.40 ± 2.57b

Notes: 1) Data mean of duplicate measurements 2) Ash, protein, and fat represented in % dry matter.

Table 2: Caffeine content of galangal-mixed coffee.

Type of sugar	No sugar	Cane sugar	Palm sugar	Alcoholic sugar
Caffeine	1.79 %	0.68 %	0.84 %	1.38 %

4.3 Ash Levels

The results of the ash content analysis showed a decrease in the value of ash content from the addition of sweeteners to coffee-galangal, where the addition of cane sugar reduced the highest ash content up to 1.74 ± 0.19^{a}%, then continued with the addition of palm sugar 2.71 ± 0.03^{bc}%, alcoholic sugar sugar as big as 3.27 ± 0.05^{c}%. The value of ash content in the treatment with the addition of palm sugar was not significantly different from alcoholic sugar, but it was significantly different from coffee-galangal with the addition of cane sugar. Decreased ash content due to differences in the value of ash content contained in the type of sweetener.

4.4 Fat content

Table 1 shows that the treatment of adding sweetener to coffee-galangal was significantly different from the value of fat content. This analysis is conducted to determine the fat content contained that can affect the taste of coffee-galangal drinks. The influence of fat content on coffee-galangal products need to be considered to determine the potential deterioration in the quality of food products during storage, due to damage to fatty acids that can reduce the value of taste and odor and nutritional quality of the product. Fat content of coffee-galangal with sweetener variants has a range of values from 3.25 to 6.79%. The results of the analysis of ash content with the lowest value is in the treatment of adding cane sugar sweetener that is equal to 3.25 ± 0.64% and the highest is in the treatment without the addition of sweetener amounting to 6.79 ± 0.04%. Fat content in coffee-galangal with the addition of cane sugar is not significantly different from palm sugar, but it is significantly different from sugar sugar and unsweetened galangal sugar.

Fat content contained in coffee-galangal products with the addition of cane sugar is not significantly different from coffee-galangal with the addition of palm sugar, but significantly different from unsweetened coffee-galangal and with the addition of alcoholic sugar. Coffee has 50% unsaturated fatty acids that is a high total fat content, this condition highly susceptible to oxidation (Rendón et al., 2014). Total fat content in Arabica coffee is between 2 - 6%, which is found in the protective waxy coating of the seeds. Decrease in the value of fat content occurs from coffee-galangal products without the addition of sweeteners, this happens because the sweetener has a very low fat content. When the addition of sweetener is done, then the fat content in coffee-galangal decreases with different percentage differences. Alcohol sugar need low concentration to have the same degree of sweetness with other type of sugar.

4.5 Protein levels

Results of ANOVA analysis (Table 1) showed that the addition of the three types of sweetener to coffee-galangal had no significant effect on protein content. Protein levels obtained in this study ranged from 4.96 - 7.5%. The highest protein content was obtained in coffee-galangal without the addition of sweetener 7.50 ± 3.15% followed by the addition of cane sugar treatment 7.21 ± 2.97%, the addition of alcoholic sugar sugar 6.44 ± 2.05% and the lowest protein content was in coffee-galangal treatment with the addition of palm sugar which is equal to 4.96 ± 0.17%. Protein content that is owned by sweeteners, such as cane sugar, palm sugar, and alcoholic sugar is very small or even absent. This is inversely proportional to the protein content contained in coffee beans which is quite a lot, namely the protein content of Brazilian Arabica Coffee of 13 -18% (19).

4.6 Caffeine Content

Many studies have attributed many positive effects to moderate daily consumption of coffee such as its polyphenolic content (Bresciani, Calani, Bruni, Brighenti, & Del Rio, 2014). The levels of caffeine in coffee-galangal with the addition of sweeteners studied were shown in Table 2. Caffeine levels varied from 0.68 - 1.79%. In general, caffeine content in unsweetened coffee-galangal content has the highest percentage, while coffee-galangal with added cane sugar has the lowest caffeine value which is 0.68%. Adding sweeteners to coffee-galangal products significantly reduced caffeine levels in coffee (Bresciani et al., 2014), the lowest caffeine content decrease was alcoholic sugar sugar. Addition of milk or sugar could affect of phenolics from coffee by in vitro availability (Otemuyiwa; Williams; Adewusi, 2017). Brewing process on one hand leads to the formation of Maillard reaction products, decomposition of chlorogenic acids and consequently may change antioxidant activity of coffee (Pilipczuk et al., 2015). The coffee consumption may decreased the risk of developing diabetes (Oba et al., 2010)

5 CONCLUSIONS

The addition of sweeteners in the form of cane sugar, palm sugar and alcoholic sugar sugar in coffee-galangal were significantly different from the unsweetened control treatments on the parameters of total carbohydrate quality, water content, ash content and fat content, but did not significantly affect protein content. The use of different types of sweeteners added to coffee-galangal products significantly ($\alpha = 5$%) on total carbohydrate content, water content, ash content and fat content. The parameter values of the chemical properties of the product in this study were: carbohydrate content of 64.47-82.60%, water content of 5.19-17.08%, ash content of 1.74 - 4.17%, fat content of 3.25 - 6.79%, protein content from 4.96 to 7.5%, and caffein content $0.68 - 1.78$%. Finding in this study showed that alcoholic sugar has the highest percentage of caffeine content and the lowest carbohydrate content. We

presume this result is useful to apply the suitable sweetener in herbal coffee and consumer accept it as one of the coffee beverage product.

6 ACKNOWLEDGMENT

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